Complementary Experiments of the Thick Line Segment Detection Algorithm: Evaluation of ADS and ATC Concepts

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Abstract

This document presents complementary experiments on the published algorithm of Thick Line Segment Detection with Fast Directional Tracking. The main paper is actually published at ICIAP 2019 [2]. First tests compare the performance of the detector with and without adaptive directional scans (ADS) and assigned thickness control (ATC). On the detector without ADS, the fine tracking step must be performed twice to get less risk of growing blurred segment escape from the scan strip.

1 Experimentations on synthesized images

These tests compare both versions on a set of 1000 synthesized images containing 10 randomly placed input segments with random width between 2 and 5 pixels. The absolute value of the difference of each found segment to its matched input segment is measured. On these groundtruth image, the numerical error on the gradient extraction biases the line width measures. This bias was first estimated using 1000 images containing only one input segment (no possible interaction) and the found value (1.4 pixel) was taken into account in the test. Results are given in the following table.

If we call S the count of pixels of all input segments in an image, D the count of pixels of all output blurred segments, and I the count of successfully detected pixels ($D \cap S$), the given measures are:

1. the count of output blurred segments,
2. the count of output long (> 40 pixels) blurred segments,
3. the count of undetected input segments,
4. the precision $P = I/D$,
5. the recall $R = I/S$,
6. the F-measure $F = 2.P.R/(P + R)$,
7. the absolute value of the width difference between matched output segments with input segments,
8. the absolute value of the angle difference between matched output segments with input segments.

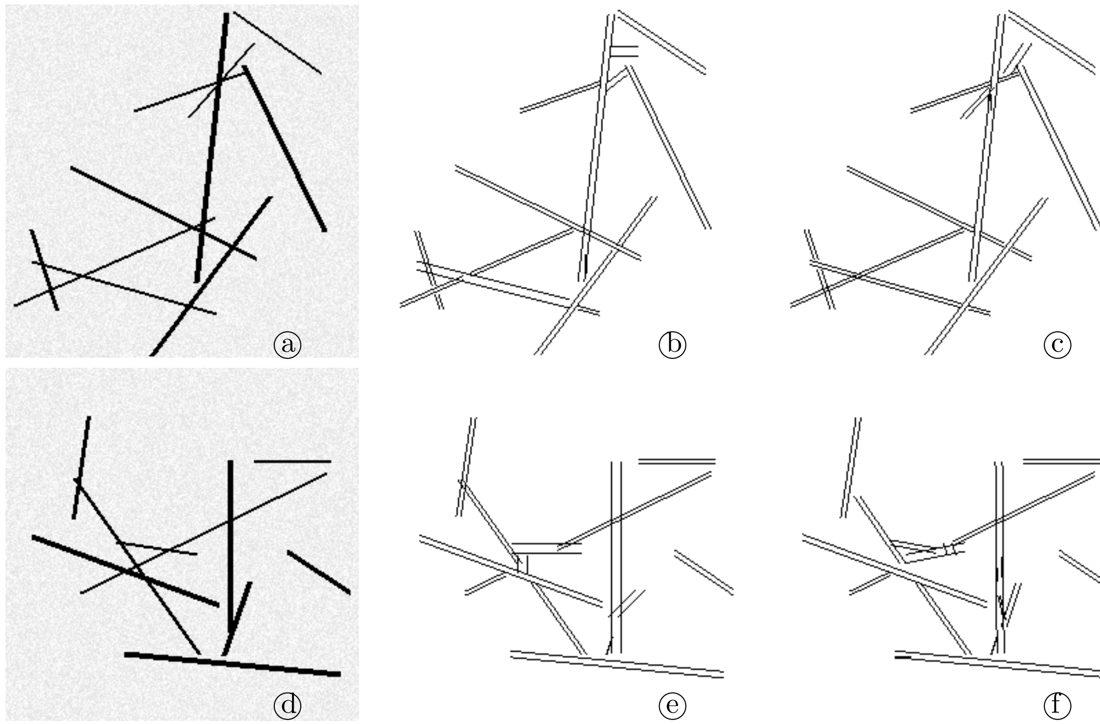

Figure 1: Evaluation on synthesized images: two of the randomly generated images (a,d), bounding lines of output blurred segments without (b,e) and with (c,f) ADS and ATC concepts.

ADS & ATC Concepts	On Fig. 1a without	On Fig. 1a with	On Fig. 1d without	On Fig. 1d with	On whole set without	On whole set with
Detected blurred segments	16	17	14	18	17.06 ±3.22	16.83 ±3.11
Detected long segments	11	8	10	10	11.24 ±1.94	11.36 ±1.97
Undetected input segments	0	0	1	0	0.152 ±0.43	0.003 ±0.05
Precision (%)	76.30	85.47	75.38	83.41	80.46 ±7.22	83.87 ±6.04
Recall (%)	89.81	93.51	90.88	91.47	90.23 ±3.30	91.15 ±2.52
F-measure (%)	82.51	89.31	82.40	87.26	84.87 ±4.42	87.23 ±3.59
Thickness difference (pixels)	0.95	0.68	1.15	0.65	0.70 ±0.24	0.59 ±0.19
Angle difference (degrees)	1.11	0.71	1.99	1.03	0.61 ±0.66	0.57 ±0.62

Table 1: Measured performance on both Figure 1 image examples and on a whole 1000 synthesized images set, without and with adaptive directional scans and assigned width control.

2 Experimentations on real images

Next tests compare both versions on real images:

- first the set of 102 images of York Urban data base [1] augmented with manually extracted groundtruth lines (an example in Fig. 1),
- then selected images for more detailed visual analysis (Fig. 3 and Fig. 4).

Reported measures in Tab. 2, Tab. 3 and Tab. 4 are execution time T, groundtruth covering ratio C (only for the York Urban data base), number of output line segments N, mean length of output line segments L/N, and mean thickness of output line segments W.

Shorter execution time is achieved with the new concepts. Detected blurred segments are shorter but thinner. Obviously the constant assigned thickness augments the probability to extend the segments with outlier edge points as can be noticed in the detail of office (Fig. 3) and castle images (Fig. 4). Moreover, brick joints are better detected in castle image.

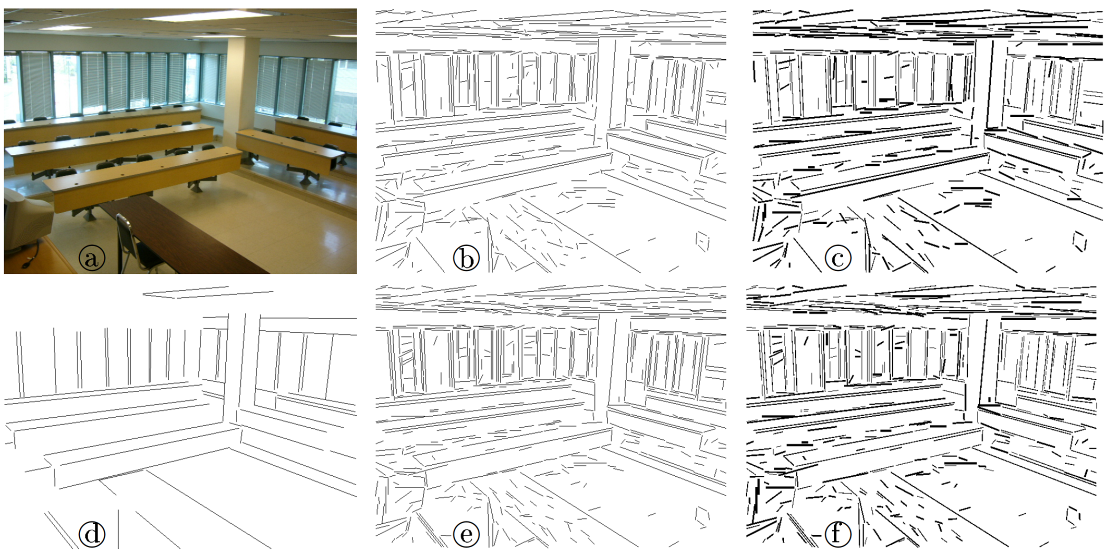

Figure 2: Automatic detection on real images: P1020928 image from York Urban data base [1] (a), the associated groundtruth lines (d), the naive lines found without (b) and with (e) ADS and ATC concepts, the thick lines found without (c) and with (f) ADS and ATC concepts.

ADS & ATC	T (ms)	C (%)	N	L/N (pixels)	W (pixels)
Without	75.19 ±16.60	70.2 ±10.1	421 ±98	46.22 ±8.60	2.20 ±0.16
With	66.62 ±15.47	67.9 ±9.6	478 ±111	41.67 ±7.53	1.89 ±0.13

Table 2: Measure with and without ADS and ATC concepts on the York Urban Database [1].

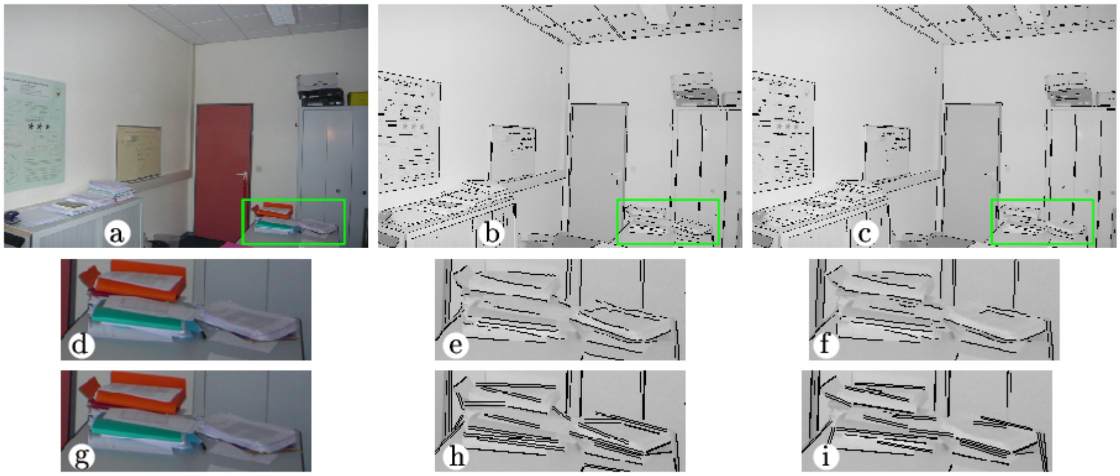

Figure 3: Automatic detection on real images: 800x533 office image (a), the segments found without (b) and with (c) ADS and ATC concepts, a detail of the image (d,g), the points of detected blurred segments without (e) and with (f) ADS and ATC concepts and the bounding lines of detected blurred segments without (h) and with (i) ADS and ATC concepts.

ADS & ATC	T (ms)	N	L/N (pixels)	W (pixels)
Without	48.16	254	53.92	1.99
With	42.17	285	49.69	1.69

Table 3: Measure with and without ADS and ATC concepts on office image.

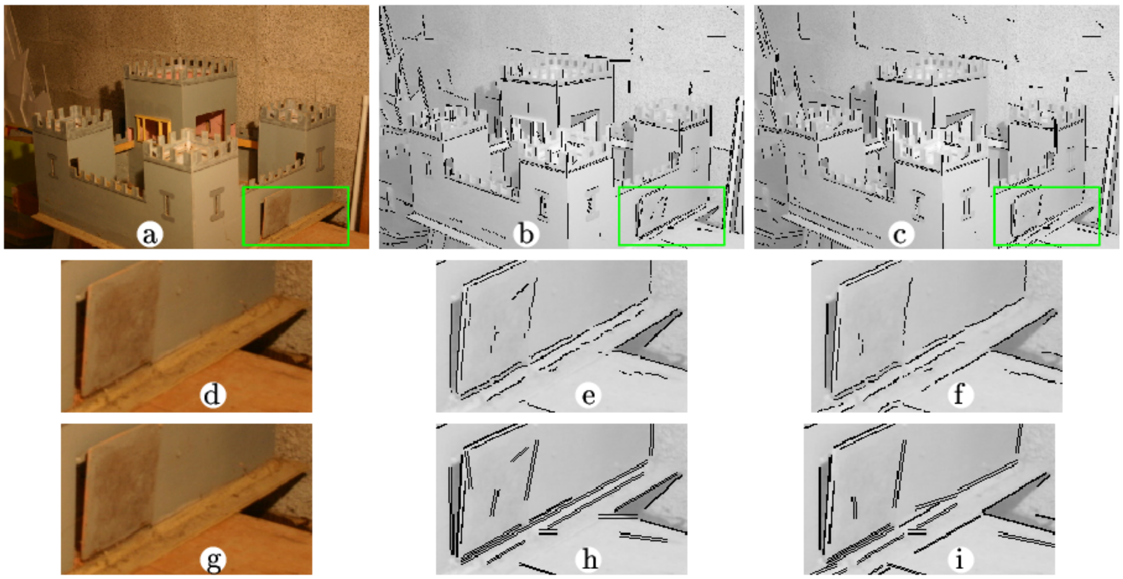

Figure 4: Automatic detection on real images: 768x512 castle image (a), the segments found without (b) and with (c) ADS and ATC concepts, a detail of the image (d,g), the points of detected blurred segments without (e) and with (f) ADS and ATC concepts and the bounding lines of detected blurred segments without (h) and with (i) ADS and ATC concepts.

ADS & ATC	T (ms)	N	L/N (pixels)	W (pixels)
Without	104.30	361	36.58	2.23
With	94.21	424	32.18	1.98

Table 4: Measure with and without ADS and ATC concepts on castle image.

References

[1] Patrick Denis, James H. Elder, and Francisco J. Estrada. Efficient edge-based methods for estimating Manhattan frames in urban imagery. In *European Conference on Computer Vision*, pages 197–210. LNCS 5303, 2008.

[2] Philippe Even, Phuc Ngo, and Bertrand Kerautret. Thick line segment detection with fast directional tracking. In *International Conference on Image Analysis and Processing*. To Appear. IAPR, September 2019.